J. Glob. Innov. Agric. Soc. Sci., 2018,6(4):115-122.
ISSN (Online): 2311-3839; ISSN (Print): 2312-5225
http://www.jgiass.com*

AGRICULTURAL WASTE PROBLEM CAN BE SOLVED WITHIN INDUSTRIAL SYMBIOSIS

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The industrial symbiosis network means the disposal of industrial wastes or their evaluation in different places in order to create a more livable environment and world. In this reason industrial symbiosis network, which is rapidly spreading to the world with the example of Kalundborg-Denmark, has reached significant dimensions both in terms of recycling of the wastes and protecting the ecosystem and bringing them into the economy. The present study was designed to show that businesses that produce agricultural and / or industrial waste can use each other's waste as inputs. In this aim of the current study; 53 enterprises were used in food (16), mining and industry (7), agriculture and livestock (9), energy (6), textile (4) and other (11) sectors. Also, this research has been made to support the establishment of new organized industrial zones according to the industrial symbiosis network for waste management.
Keywords: Industrial symbiosis, industrial ecology, environment, industry, agricultural waste.

INTRODUCTION

The technology developed in parallel with the rapid increase in the world population has made people more consuming society. In order to meet the increasing demand, it is important to present new solutions and to carry on vital activities. The world population is known to be 7.7 billion. This rapid increase threatens the vital space in the world and brings environmental and economic concerns. At this point, innovative approaches that emphasize communication and cooperation are put forward in the new world order where the borders separating countries and sectors are removed. These approaches improve the culture of the sectors and provide added value to the sectors / organizations in the symbiosis network and take care of the environment and social benefit. In this context, the industrial symbiosis, which is the whole system; offering multipurpose opportunities for institutions that have a new understanding and vision, aims to bring together a dynamic network. Industrial symbiosis helps to reduce the environmental impact, provide every participant in the economic structure and develop a culture of cooperation among various industrial organizations. Industrial symbiosis, which refers to the same approach as industrial ecology, aims to establish long-term partnerships improving environmental performance and competitiveness of two or more sectors / organizations which are physically close to each other but normally work independently. This approach is not only to prevent industrial problems but also to provide economic returns to bring together the industrial symbiosis network of different industries and organizations (Ulutas, 2011).

In the second half of the twentieth century, the environmental adversities, caused by the rapidly developing technological and industrial developments and the rapid decline of the non-renewable natural resources, are increasing in the world. The wastes, generated in parallel with industrialization, have increased significantly over time and the local environmental problems, experienced by these wastes, have gained a global dimension. It is also the part of the sustainable rural and agricultural development (Gülçubuk *et al*., 2015). Nowadays, industrial symbiosis helps to reduce environmental damages, develops the culture of cooperation between various industrial organizations and provides economic return to every participant. In this context, physical change of materials, energy, water or/and by-products among the organizations; all kinds of resources, logistics and an efficient use of resources and expertise that will allow the company to move in together thinking along the common benefits are realized in other areas (Chertow, 2000). In this respect, the environmental management systems that can be designed for industrial zones such as Organized Industrial Zone (OIZ), by-products, residues or wastes produced by an enterprise can be used as raw material for another enterprise. In this way, industrial problems are not only prevented by environmental problems, but also provide economic return.

Industrial symbiosis encountered in Denmark in the 1970s to the first application in the world. Today, is being applied in many countries such as the UK, Norway, the Netherlands, Australia, Germany, Italy, America, South Korea, China, Mexico, Brazil and Australia. The national industrial symbiosis program in the UK since 2005 is one of the most successful examples in the world (Anonymous, 2012). Within

the program, while the savings of enterprises increased by about £ 250 million per year, 9 million tons of CO_2 emissions decreased by eight million tons. BTC Company in 2009 as the first in Turkey (Baku-Tbilisi-Ceyhan Oil Pipeline Company); In order to support sustainable regional development in the pipeline route, the industrial symbiosis which came into the agenda with the project realized in the Gulf of Iskenderun was carried out after various feasibility and evaluation studies of the company. The implementation phase started in 2011 TTGV (Technology Development Foundation of Turkey) and the application phase of the project with the cooperation agreement between BTC Company began in TTGV executive. The project work, which ended in 2012, was co-operated with International Synergies Limited (ISL), the executive director of the UK National Industrial Symbiosis Program (NISP), and the Environmental Engineering Department of Middle East Technical University (TTGV, 2015).

Clustering Study: Approximately 1.2 billion tons of petroleum agricultural waste is generated annually worldwide (Anonymous, 2018a). Therefore, the disposal of agricultural waste produced in the world in general or giving back to the economy are very important in terms of environmental cycle. This objective will be made an example of by industrial symbiosis network clustering study recognized that agricultural waste. In current study 53 enterprises were used including food (16), mining and industry (7), agriculture and livestock (9), energy (6), textile (4) and other (11) sectors (Fig. 1). Prepared sectoral based industrial symbiosis samples will help new companies to use waste as inputs to other companies. In addition, companies will have the opportunity to easily manage waste management before the establishment of Organized Industrial Zone (OIZ).

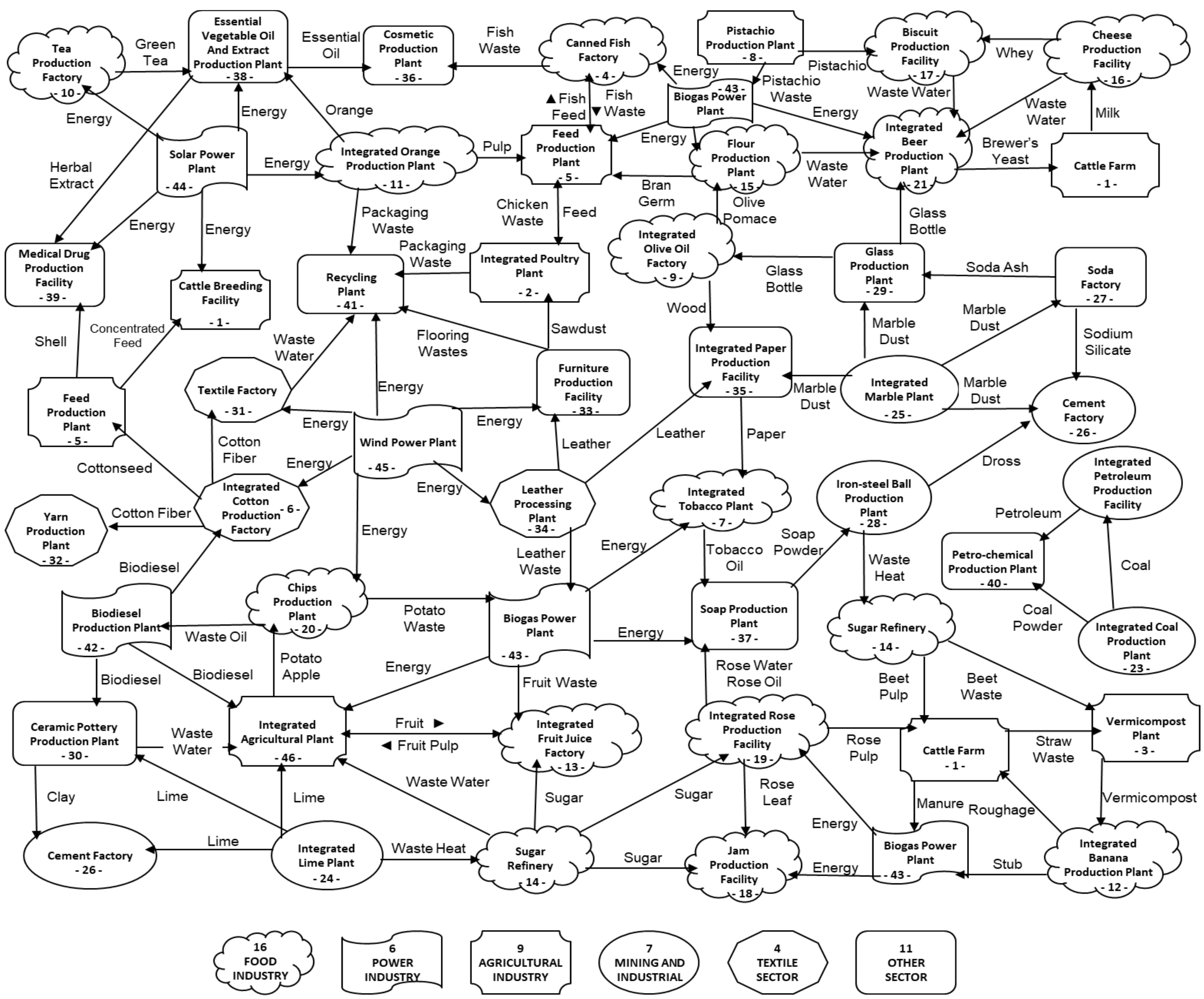

Figure 1. Industrial Symbiosis Network Example.

Table 1. Industrial Symbiosis Network Example.

No.	Factory or Plant	Raw Material or Input	Waste or Output	References
1	Cattle Farm	Roughage and Concentrate Feed, Energy	Animal Manure, Straw Waste	Öztürk, 2005; Tolay et al., 2008; Kilic et al., 2018
2	Integrated Poultry Plant	Feed, Energy, Packaging Material	Packaging Waste, Chicken Manure, Bone, Giblets, Blood Flour	Görgün et al., 2018; Uzun and Sargın, 2018
3	Vermicompost Plant	Household Waste, Compost, Pulp, Animal Manure	Vermicompost	Taylor et al., 2003; Erşahin, 2007
4	Canned Fish Factory	Feed, Energy, Packaging Material	Fish Oil, Fish Waste, Packaging Waste	Kilinc, 2007; Akagündüz, 2010
5	Feed Production Plant	Grain, Pulp, Energy, Feed Additives	Packaging Waste, Powder, Grain Shell, Grain Waste	Horuz et al., 2015
6	Integrated Cotton Production Factory	Cotton, Energy	Cotton Seed, Ginning, Cotton Waste	Usta et al., 2003; Alkaya, 2010
7	Integrated Tobacco Plant	Tobacco, Energy, Packaging Material	Tobacco Oil, Waste Water	Çalişkan et al., 2009; Çerçioğlu, 2011
8	Pistachio Production Plant	Pistachios, Manure, Energy	Pistachio Glume, Pistachio Shell	Salan and Almab, 2014; Anonymous, 2018b
9	Integrated Olive Oil Factory	Olive, Glass Bottle, Energy	Olive Mill Waste Water, Olive Pomace, Olive Tree Branch Part	Seferoğlu et al., 2008; Bain et al., 2010; Aktaş and Salih, 2014
10	Tea Production Factory	Tea, Energy, Packaging Material	Tea Waste, Packaging Waste	Aşik and Kütük, 2012; Bilgin et al., 2016
11	Integrated Orange Production Plant	Energy, Manure, Packaging Material	Orange Pulp, Packaging Waste, Waste Water	Günkaya et al., 2016; Filik and Kutlu, 2018
12	Integrated Banana Production Plant	Energy, Manure, Packaging Material	Banana Cob, Banana Leaf, Packaging Waste	Sözer and Yaldiz, 2011; Topbaşli and Sevinçli, 2017
13	Integrated Fruit Juice Factory	Fresh Fruit, Energy, Packaging Materials	Fruit Pulp, Waste Water	Yang and Feng, 2008; Yalçinkaya et al., 2012; Bektaş and Gülmez, 2012
14	Sugar Refinery	Sugar Beet, Energy	Pulp, Cake, Bioethanol, Waste Water	Kahyaoğlu and Konar, 2006; Dönmez, 2010; Altunbay et al., 2016
15	Flour Production Plant	Wheat, Corn, Energy, Packaging Materials	Bran, Razmol, Waste Water, Wheat Red-Dog, Wheat Germ	Fane and Fell, 1977; Ertop et al., 2016
16	Cheese Production Facility	Milk, Energy, Yeast, Packaging Materials	Whey, Packaging Waste	Sözer and Yaldız, 2006; Dinçoğlu and Ardıç, 2012
17	Biscuit Production Facility	Whey, Sugar, Oil, Flour	Packaging Waste, Waste Water	Ünal and Katkat, 2003; Khare and Bundela, 2014
18	Jam Production Facility	Fruit, Rose Leaf, Sugar, Packaging Materials	Packaging Waste, Waste Water	Ruffino and Zanetti, 2017
19	Integrated Rose Production Facility	Rose, Manure, Energy, Packaging Materials	Rose Pulp, Waste Water	Onursal, 2006; Akar, 2012
20	Chips Production Plant	Potato, Apple, Vegetable Oil, Energy	Potato-Apple Waste, Waste Oil	Çanakçi and Özsezen, 2005; Uçaroğlu et al., 2016
21	Integrated Beer Production Plant	Barley, Energy, Packaging Materials	Packaging Waste, Beer Yeast	Kaur and Saxena, 2004; Han et al., 2006; Ferreira et al., 2010; Bain et al., 2010
22	Integrated Petroleum Production Facility	Crude Oil, Coal, Energy	Asphalt	Nezahat et al., 2000
23	Integrated Coal Production Plant	Coal, Petroleum, Energy, Packaging Materials	Coal Powder, Packaging Waste	Aydoğan et al., 1990
24	Integrated Lime Industry Plant	Limestone, Energy	Lime Waste, Waste Heat	Yang and Feng, 2008; Akyarli et al., 2009
25	Integrated Marble Plant	Raw Marble, Energy	Marble Powder, Palette, Rubble	Akbulut and Gürer, 2006; Timur and Kiliç, 2013

No.	Factory or Plant	Raw Material or Input	Waste or Output	References
26	Cement Factory	Limestone, Marl, Clay, Sodium Silicate	Ash Kinds, Phosphogypsum, Silica Powder	Zhu et al., 2007; Ulutaş, 2013; Demirel and Çağlar, 2015
27	Soda Factory	Trona, Energy, Packaging Materials	Calcium Carbonate, Calcium Hydroxide, Sodium Silicate	Gür, 2014
28	Iron-Steel Ball Production Plant	Raw Steel, Coke Coal, Soap Powder, Energy	Slag, High Heat, Liquid Steel Pulp	Dong et al. 2008; Uysal and Bahar, 2018
29	Glass Production Plant	Sand, Soda, Limestone, Dolamit, Energy	Broken Glass Fittings	Kavas et al., 2004; Özkan, 2007
30	Ceramic Pottery Production Plant	Marble Powder, Soil, Lime, Energy	Clay, Waste Water	Ateş, 2007; Murathan et al., 2013
31	Textile Factory	Cotton Fiber, Paint, Energy	Jute Waste, Waste Water, Short Asbestos Fibers, Cotton Linter Pulp	Kalin, 2005; Kozak, 2010
32	Yarn Production Plant	Olive Leaf, Energy, Cotton Fiber	Cotton Powder, Waste Water	Alkaya, 2010; Üçgül and Durak, 2015
33	Furniture Production Facility	Leather, Wood, Glass, Sponge, Fabric, Metal, Energy	Flooring Waste, Powder, Sawdust	Narlioğu et al., 2018
34	Leather Processing Plant	Raw Leather, Paint, Chemical Matter, Energy	Feather, Leather Fittings, Wastewater	Yilmaz, 2005
35	Integrated Paper Production Facility	Wood, Plants, Chemical Matter, Energy	Waste Water	Uğurlu et al., 2003; Zhu et al., 2007
36	Cosmetic Production Plant	Essential Oil, Essence, Vitamins, Energy	Silicone, Waste Water, Packaging Waste	Bayhan and Değermenci, 2017
37	Soap Production Plant	Vegetable Oils, Chemical Matter, Energy	Polypropylene, Waste Oil, Soap Powder, Waste Water	Yapijakis and Wang, 2006
38	Essential Vegetable Oil and Extract Production Plant	Herbal Products, Solvents, Energy	Pulp, Waste Water, Packaging Waste	Yaman, 2012; Baiano, 2014
39	Medical Drug Production Facility	Herbal Extracts, Chemical Matter	Packaging Waste	Budak and Çobanoğlu, 2013
40	Petro-Chemical Production Plant	Petroleum, Plastic Waste, Energy	Waste Water	Parilti, 2011
41	Recycling Plant	Plastic, Metal and Glass Wastes, Waste Water, Energy	-	Gündüzalp and Güven, 2016
42	Biodiesel Production Plant	Vegetable and Animal Oils, Alcohol	Biodiesel	Çildir and Çanakçi, 2006; Çengelci et al., 2011
43	Biogas Power Plant	Organic and Agricultural Waste, Manure	Energy	Kafle et al., 2013
44	Solar Power Plant	Sunlight	Energy	Pearce, 2008; Mekhilef et al., 2011; Taşkin and Vardar, 2016; Torshizi and Mighani, 2017
45	Wind Power Plant	Wind	Energy	Özdamar, 2000; Bošnjaković, 2013
46	Integrated Agricultural Plant	Energy, Lime, Pulp, Waste Water	Fruit, Vegetables	Erşahin, 2007; Filik and Kutlu, 2018

According to this study wastes of different sectors can be taken as product (input) of other sector and processed. Thus, connections between various companies can be established and can provide environmental health, gain from the field and economic contribution. In the Table 1 it is stated that which sectors inputs (products) and outputs (wastes) can be used in the industrial symbiosis network.

If the industrial network is not used, only some examples of the damage caused to the environment by some of the wastes will be seen more clearly in terms of economy and the environment:

Lime**:** Lime is produced by the heating calcareous or limestone in nature. So as to make lime from calcareous or limestone, the internal temperature of the incinerator must be above 90-1200°C. Thus, lime is converted to calcium oxide in high degrees. This heat of the exhaust gas to the environment during the conversion is between approximately 25-300°C. During the heat treatment the atmosphere together

with the high temperatures resulting from flue fuel gas, carbon monoxide (CO) and emission of various gases by air spheres under great threat trigger global warming (KİSAD, 2015). For example, 3.5 million years ago, only one kind of natural causes disappeared for a thousand years, while in the 2000s, this figure will increase from 20 thousand to 50 thousand (Anonymous, 2014). Owing to the negative effects of the wastes and fumes of the factories around the Copper Mountains in the USA, the entire plant ecosystem in that region has been destroyed.

***Waste water*:** which is in the negative output of 95% of the industrial enterprises, interferes with the sea and land ecosystem in a variety of ways by interfering with the groundwater, drinking water and seas. Waste water contamination from the contamination of available clean sources puts both humanity and plant and animal populations into the risk zone (TBMM, 2013).

***Packaging waste*:** This will be processed, recycled and collected discarded by invading the area where the earth leads to significant loss of land. Leather, wood, glass, plastic, metal, fabric, slag etc. parts of the wastes are also recycled in terms of environmental health and gain from the area. D-Waste, ISWA, University of Leeds, WtERT, Sweep-Net and SWAPI, which are included in the Waste Atlas Partnership, have produced 2 years of waste atlas. In the report, a map and a profile of the world's 50 largest active waste dumps have been created and it is reported that approximately 40% of the waste produced in the world is disposed of in an unhealthy way in open waste areas. In most of these dumps it is close to urban areas, but also stated that poses a serious threat to human health and the environment. According to this report; waste of 200-300 times the volume of the Giza Pyramid, or 0.6-0.8 km^3 of waste, which can affect the daily life of 64 million people (ÇEVKO, 2015)

As can be seen from the examples given above, industrial symbiosis is the beginning stage of the new generation technology age industry 4.0. In addition, policy makers and local administrators should strive to ensure that investments in their regions are appropriate for the industrial symbiosis network (Chertow, 2007).

***Conclusion*:** In recent years, rapidly evolving consumption habits with industrialization has increased the amount of domestic and industrial waste. Therefore, wastes will be allowed to be evaluated in a way that will not harm the environment. On the one hand, the use of scarce resources and the prevention of environmental pollution on the other hand can be achieved by recycling the wastes to the nature. In particular, rapid and new developments in science and technology have paved the way for the evaluation of industrial wastes. Increasing of new recycling methods and re-evaluation of wastes has the potential to prevent environmental pollution. As a result, the spreading of inter-enterprise cooperation in the structured clustering study is very important in the evaluation of wastes, which is one of the biggest environmental problems. Through the organized industrial symbiosis network to be used in newly established, new business opportunities will be provided both high rates of economic income.

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